EDITORIAL

The Human Microbiome

Gregory A. Plotnikoff, MD, MTS, FACP, *United States*; David Riley, MD, *United States*

Author Affiliations
Penny George Institute for Health and Healing, Abbott Northwestern Hospital, Minneapolis, Minnesota (Dr Plotnikoff); *Global Advances in Health and Medicine* (Dr Riley).

Correspondence
Gregory A. Plotnikoff, MD, MTS, FACP
Gregory.plotnikoff@allina.com

Citation
Global Adv Health Med. 2014;3(3):4-5. DOI: 10.7453/gahmj.2014.023

Key Words
Microbiome, gut, diversity

In 2011, at the Society for Integrative Oncology's international meeting in Cleveland, Ohio, Francis Collins, PhD, head of the National Institutes of Health, shocked the audience when he asserted that although his work in the human genome was exciting, he was more impressed by the potential represented by the National Institutes of Health's investment in the Human Microbiome Project. "This is the future," he stated with great certainty. Surprisingly, this is also the past. More than 100 years earlier in 1908, Ilya Ilyich Metchnikov, co-winner of the 1908 Nobel Prize for Medicine, noted that "the dependence of the intestinal microbes on the food makes it possible to adapt measures to modify the flora in our bodies and to replace harmful microbes by useful microbes."[1] He coined the term *dysbiosis* to describe microbial ecological imbalance in the gut.

What happened between 1908 and 2011? Until recently, clinicians and scientists, blinded by the discovery of antibiotics, seemingly forgot this perspective. And the bacteria that make up the human microbiome could not be cultured outside the gut using classical microbiological techniques. Moreover, one cannot grow the human microbiome in a Petri dish—the relationships are too complex and interdependent.

However, researchers are now able to identify bacterial species without culture through the eyes of high-throughput screening that can catalogue million of sequences at a time looking for ribosomal RNA segments specific for bacteria (16S rRNA). Supercomputers can manage and analyze the immense data generated. The result is that scientists are now able to describe both normal and abnormal micobiota per anatomical site on the body. And clinician researchers are now successfully transplanting new microbiota as a therapy for refractory *Clostridium difficile* infection.[2]

What we have learned may shock humans who believe in autonomy. The fact is that although we humans comprise approximately one trillion cells, our gut microbiota consists of approximately 10 to 100 times more cells. And although we humans comprise approximately 20 000 genes, our intestinal microbiome has approximately 150 times more genes. In fact, scientists can now state with irrefutable evidence that our microbiome influences our metabolism, physiology, and gene expression in multiple ways relevant to mood, energy, and immune function.

We humans possess an "extended genome" and function not as autonomous beings but as a complex biologic "superorganism."[3] This revolution in understanding our microbial symbionts promises equally

Glossary

Classification: Taxonomic classification of microbes are reported as phyla, genus, species, and strain. The microbiota is dominated by two bacterial phyla, the gram-negative Bacteroidetes and the gram-positive Firmicutes. Other phyla include Actinobacteria, Fusobacteria, and Verrucomicrobia. Microbial diversity exists at the lower taxonomic levels of genus, species, and strain.

Commensal: Non-harmful co-existence.

Dysbiosis: Imbalance in the structural or functional configuration of the microbiota, leading to a disruption of host-organism homeostasis. This has been demonstrated in multiple disease states such as functional bowel disorders, inflammatory bowel disease, cirrhosis, allergies, diabetes, and obesity.

Gnotobiotic: Describes laboratory mice that are in sterile (germ-free) conditions or colonized with a specific microorganism or microorganisms. Use of gnotobiotic mice has led to discoveries of the role that the microbiota play in carcinogenesis, chemotherapy metabolism, etc.

Microbiome: The communities of microorganisms from the three kingdoms of bacteria, yeast, and archae plus viruses that populate a location such as the large intestine. The human microbiome consists overwhelmingly of bacteria, most of which colonize the large intestine.

Microbiota: The assemblage of microorganisms that exists in a previously established environment. This is the preferred term for the microbiome. The gut microbiota was also formerly called the gut flora. More than 1000 species can be found in the human gut microbiota but only 150 to 170 predominate in any one person.

Mutualistic: Mutually beneficial.

Prebiotic: Non-digestible food components that stimulate the activity or the growth of the beneficial intestinal bacteria termed bifidobacteria and lactobacillus. Examples include fermented foods (sauerkraut, kimchi, kefir); cultured foods (yogurt,

revolutionary understandings of health, disease, and therapeutic interventions.

Truly, we have discovered an entirely new organ system that not only is responsible for proper intestinal functioning including gut motility, immunity, and permeability but also plays an important role in previously unrelated topics as osteoporosis, anxiety, pain perception, adiposity, and carcinogenesis. This means that all health professionals are now challenged to come up to speed on this newly emerging cross-disciplinary field of inquiry. To foster such professional growth and development, this issue of *Global Advances in Health and Medicine* has assembled a variety of perspectives on the power of the human microbiome. For example, noted visionary Patrick Hanaway, MD, opens the issue by addressing the topic of diversity. He reminds us that the composition of our microbiota is unique to each person and that like every ecological system, resilience depends upon preservation of diversity. Award-winning journalist Steve LeBeau interviews Alexander Khoruts, MD, one of the leaders in the new world of fecal microbial transplants. Dr Khoruts reviews the US Food and Drug Administration's current regulations and proposes ways to advance the field. Readers will also find several original articles, three provocatively exciting reviews from leaders in their field, and an original case study. For readers, this issue guarantees new insights into how understanding the microbiome will revolutionize care.

To support every reader's entrée into this new topic, the editors have included the following glossary. We know that in this issue, you will again find *Global Advances in Health and Medicine* living up to its name and promise. And, as always, we welcome your feedback and comments.

REFERENCES

1. Metchnikoff E. The Prolongation of Life: Optimistic Studies. Putnam, New York, 1908.
2. LeBeau S, Khoruts A. Fecal Microbiota Transplantation: An Interview With Alexander Khoruts. Global Adv Health Med. 2014;3(3). DOI: 10.7453/gahmj.2014.020.
3. Kinross JM, von Roon AC, Holmes E, Darzi A, Nicholson JK. The human gut microbiome: implications for future health care. Curr Gastroenterol Rep. 2008; 10(4): 396-403.

Glossary (*cont.*)

cottage cheese, tofu); and foods rich in inulin, fructooligosaccharides, and galactooligosaccharides (very long list).

Probiotic: Live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. Commonly, these consist of Lactobacillus and Bifidobacteria bacterial species but can also include other bacterial species as well as beneficial yeast such as *Saccharamyces boulardii.*

Symbiotic: Literally, "living together." Symbiosis can be mutualistic, which is the commonly understand version, as well as parasitic. Symbiosis can be obligate, as in both organisms require each other in order to survive, or facultative, meaning that symbiosis is not required for survival.

Xenobiotic: Refers to foreign compounds that are neither produced nor naturally found in a host. The intestinal bacteria participate in the metabolism of xenobiotic chemicals.

Mind-Body-Spirit Medicine

with Mimi Guarneri, MD, FACC, ABIHM™

Included in the ABIHM E-Learning Library: Over 60.5 *AMA PRA Category One Credits* of outstanding, evidence-based, & clinically relevant education delivered with heart.

www.abihm.org